US-PAT-NO: 6574477

DOCUMENT-IDENTIFIER: US 6574477 B1

TITLE: Dynamic load balancing during message processing in a wireless communication service network

---------- KWIC ---------

Brief Summary Text - BSTX (10):

Existing wireless network signaling systems are implemented using programmed computers. These processing elements are referred to by various names, including "application processors" (APs). They are usually located in a mobile switching center (**MSC**), or in a base station controller (BSC) if such is in use in the mobile communication network. For convenience, the terms "application processor" and "AP" will be used hereinafter to refer to a signal processing component (described in more detail below) that processes signaling messages on behalf of cell base stations. The use of these terms is not intended to signify any particular architecture or commercial product offering.

Brief Summary Text - BSTX (11):

In some wireless communication networks, such as the FLEXENT.TM. system from Lucent Technologies Inc., signaling functions are implemented on behalf of cell base stations by clusters of application processors arranged in a networked environment. The application **processors act as network servers** that maintain signaling links to the cell base stations, which function as subtending network client elements. Each application processor supports a fixed number of signaling links extending to several subtending cells (of different type and size).

Brief Summary Text - BSTX (18):

Accordingly, there is a need in a wireless communication network, and particularly a wireless network implementing clustered application processors providing message signaling support, for improved control of message processing resources in response to changes in message traffic conditions in the the subtending cells. What is required is a message control system that is dynamically configurable in response to changing message traffic conditions in order to promote improved **load sharing** among operational application processors. In a further aspect, an application processor **load sharing** arrangement is needed in order to minimize service impairments arising from application processor overload and/or the effects of an interruption in application processor functionality as a result of failure, maintenance operations, or otherwise.

Detailed Description Text - DETX (2):

Turning now to the figures, wherein like reference numerals represent like elements in all of the several views, FIG. 1 illustrates an exemplary wireless communication network 2 that is particularly adapted for mobile subscribers. As such, the wireless network 2 includes a mobile switching center (**MSC**) 4 that provides call support for plural cells, one of which is shown by reference number 6. As is known in the art, each cell in the wireless communication

system 2 serves mobile (or non-mobile) radio units operating within a defined geographic area. The cells can be of various type, including conventional minicells, as well as microcells and modular cells ("modcells"). As is known, microcells are especially suited for extending wireless network coverage into high traffic areas, such as buildings, as well as sparsely populated low traffic areas. Modular cells allow service providers to build cells of varying size as a result of the modular design of the cell base station equipment.

Detailed Description Text - DETX (3):

As will be understood by persons skilled in the art, the **MSC** 4 conventionally includes a Common Node Interface (CNI) ring 8 that provides communication between a plurality of ring nodes. These include one or more Call processing Database Nodes (CDN) 10 and 12, an Administrative Call processing Database Node (ACDN) 14, and a 3B21 processor node 16. An Executive Cellular Processor (ECP) 18 and an Operations and Maintenance Processor (OMP) 20 running a user interface front end 22, which could be implemented by way of example only, using the Lucent Technologies Inc. EMS (Element Management System) software product 22. The EMS user interface product is especially suited to allow service providers to configure application processor radio control software. It is contemplated that the dynamic load balancing described herein could be performed manually by system personnel using this interface. Other user interfaces, such as an interface (not shown) provided by the 3B21 processor node 16, could also be used to perform dynamic load balancing as described herein.

Detailed Description Text - DETX (4):

The cell 6 communicates with the **MSC** 4 via a network switching element 30 and a pair of application processors (hereinafter referred to as "AP"s) 32 and 34. Each AP 32 and 34 connects to the CNI ring 8 via an Ethernet Interface Node (EIN) 36 and 38, respectively. An appropriate communication link 40 (such as a T1 or E1 facility) provides two channels (e.g., DS0 channels) dedicated to carrying signaling messages between the cell 6 and the network switching element 30. These channels may also be referred to a primary and secondary links. The switching element itself can be implemented as a Lucent Technologies Inc. 5ESS switch, or the like. It maintains a Digital Facilities Interface (DFI) 42 that terminates one end of the communication link 40 and DFI groups 44 and 46 that terminate communication link groups 48 and 50 extending to the APs 32 and 34, respectively. The DFI 42 routes one signaling channel from the cell 6, shown by reference numeral 52, to the DFI group 44. The other signaling channel from the cell 6, shown by reference numeral 54, is routed to the DFI group 46. It will thus be seen that message traffic to and from the cell 6 can be routed on separate "nailed-up" signaling links respectively extending to the APs 32 and 34.

Detailed Description Text - DETX (11):

The foregoing dynamic load balancing can be performed either manually by wireless network operational personnel, or automatically. More specifically, these operations can be performed a manner now to be described. For the manual load balancing operation, the user interface 22 (or any other suitable user interface associated with the **MSC** 4) can be used. The user interface 22 would provide input to, and receive output from, appropriate cluster administration software 84 that could run on one or both of the APs 32 and 34, or on some other AP within the AP cluster to which the APs 32 and 34 belong. The user interface 22 allows a system operator to issue administrative commands that instruct the cluster administration software 84 to change the active-standby

and primary-secondary designations for selected pairs of the RCS instances 60 and 62 that serve a common cell or group of cells. An administrative command to change the active-standby designations for a selected RCS instance pair results in a switch-over of message traffic from the primary/active RCS instance to the secondary/standby RCS instance in the pair so that the work load is thereby shifted.

Detailed Description Text - DETX (14):
As part of the manual load balancing operation, the system operator may also elect to change the primary-secondary designations for the selected RCS pair, so as to make the active-standby designation changeover permanent. In that case, an RCS database 86 that stores the primary-secondary designations for the RCS instances 60 and 62 is updated. Copies of this database could be located anywhere within the **MSC** 4. For example, one copy of the RCS database 86 could be maintained at the 3B21 processing node 16, particularly if this processing element also provides a user interface for the dynamic load balancing operation. Another copy could be maintained at the OMP 20. Other copies of the RCS database 86 could be respectively stored on the disk drives 64 and 66. The RCS database permanently stores the primary-secondary designations for the RCS instances that it manages. It is provisioned by the service provider to select the primary RCS instance in an RCS pair for active mode operation following system initialization. Thus, the RCS database allows RCS load balancing changes to be maintained across system reboots. As will be understood by persons skilled in the art, many species of database could be used, including a flat configuration file maintained in a conventional (e.g., Unix) file system, or a commercial database product having a standard interface for storing, retrieving and updating records therein.

Detailed Description Text - DETX (25):
Accordingly, a message control system for a wireless communication network has been described that includes at least two APs, and implements dynamic **load balancing and distributed** mated-pair processor redundancy. The invention provides an architecture for maximizing performance and reliability of RCS service in an **MSC** or BSC. The invention allows a hosting AP to utilize at least 30%-60% more CPU capacity than in prior art systems lacking dynamic **load balancing capability or distributed** mated-pair functionality. The invention will enable capacity maintenance operations to be performed on-line for subtending cells by allowing system administrators to change the active-standby or primary-secondary designations for selected RCS instances running on APs within an assigned group of APs. The load can be re-assigned (balanced) between any number of processors without taking any cells off-line or moving communication link facilities. AP CPU thresholds are thus easily tunable to accommodate different numbers of APs in an AP group.

Detailed Description Text - DETX (26):
Supporting up to 8 active and 8 secondary RCS instances on each AP in a simple two processor arrangement can lead to 65,536 (2 to the power of 16) combinations of workload distribution and even more in four or eight processor arrangements. When the load balancing of RCS instances is automated, the **MSC** or BSC environment is moved toward the goal of being system-managed where conscious operator intervention for ensuring optimal levels of performance or reliability will be the exception rather than the rule.